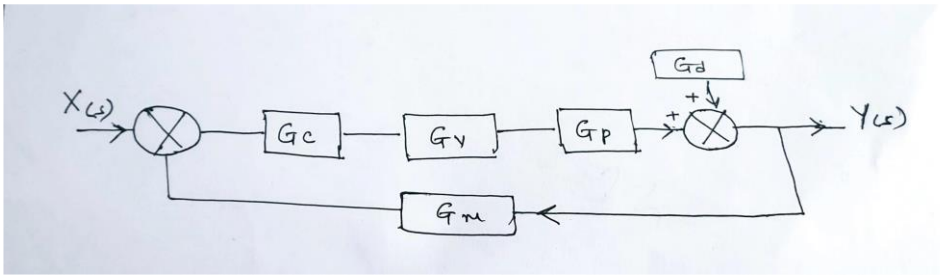
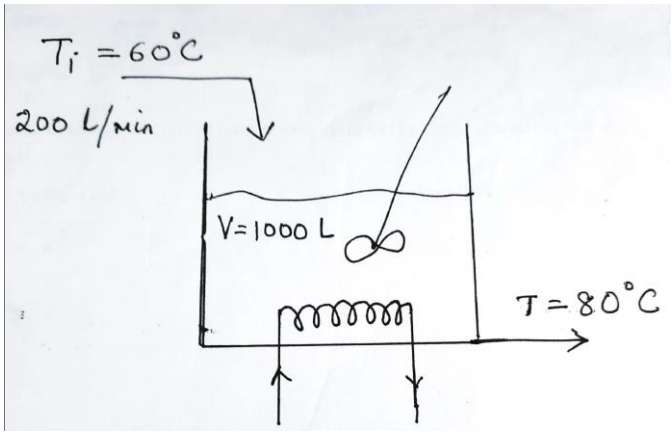
SVKM's
D. J. Sanghvi College of Engineering

Program: B.Tech in Chemical Engineering **Academic Year: 2022** **Duration: 3 hours**
Date: 09.01.2023
Time: 10:30 am to 01:30 pm
Subject: Process Dynamics and Control (Semester VII) **Marks: 75**

Instructions: Candidates should read carefully the instructions printed on the question paper and on the cover page of the Answer Book, which is provided for their use.

(1) This question paper contains three pages.
(2) All Questions are Compulsory.
(3) All questions carry equal marks.
(4) Answer to each new question is to be started on a fresh page.
(5) Figures in the brackets on the right indicate full marks.
(6) Assume suitable data wherever required, but justify it.
(7) Draw the neat labelled diagrams, wherever necessary.

Question No.		Max. Marks
Q1 (a)	Mention the hardware components used in a control system. **OR** Why is linearization required in process dynamics? Explain with an example.	[05] [05]
Q1 (b)	A control system having transfer function as $G(s) = \frac{Y(s)}{X(s)} = \frac{5}{1.8\,s^2+3s+5}$ is given step change of magnitude 5. Find the (i) Value of Y(t) at t = 0.5min. (ii) Overshoot (iii) Cyclical frequency	[10]
Q2 (a)	Two noninteracting tanks are connected in series. The time constants are τ_1=0.5 and τ_2=1.0 ; R_2 =1. Find the response of the level in tank 2 if step change of 5 units is made in the inlet flow rate to tank 1. Find height of tank 2 after 5min. **OR** Test stability of the given characterstic equation using Routh Hurwitz method. $1 + \frac{K}{(15s+1)(60s+1)} = 0$	[10] [10]
Q2 (b)	Write short note on Ziegler Nichols Tuning method.	[05]
Q3 (a)	A thermometer having first order dynamics is at steady state temperature of 30°C is subjected to impulse of magnitude 50 °C. The time constant for thermometer is 6 second. Calculate the temperature indicated by thermometer at t=3second and t=18sec.	[05]

	OR Considering Proportional controller ; Gv= $\frac{1}{2s+1}$; Gp = Gd=$\frac{1}{5s+1}$; Gm=1, find the closed loop transfer function considering servo problem. 	[05]
Q3 (b)	For the following tank heating system with water, (Assume Specific heat capacity as 4.184 KJ/ kg ℃). (a) Determine the response equation of the outlet temperature of the tank to a step change in the inlet temperature from 60 to 70 ℃. Find the temperature after 5 min. (Here assume no change in heat input). (b) Determine the response of the outlet temperature of the tank to a step increase in the heat input of 42 kW. Find the temperature after 5 min. (Here assume no change in inlet temperature). 	[10]
Q4 (a)	An aqueous solution is mixed in a tank. The density of solution is 900 kg/m^3. The feed rate is 1.5 m^3/min and the volume of tank is 1.5 m^3. The steady state concentration of the solution is 0.03 kmol/ m^3. The inlet concentration of the feed is given step change and increased to 0.08 kmol/ m^3. Calculate the outlet concentration of the solution for t = 1 min and t =1.5 min. **OR** Plot Root locus diagram for the open loop; G_{OL}= $\frac{Kc}{(s+1)(2s+1)}$. Comment on the stability of system with varying values of Kc.	[10] [10]
Q4 (b)	A pneumatic controller is used to control as the temperature changes from 90-105 ℃ for the output change from 30 to 90 kN/ m^2. Calculate the gain of the controller.	[05]

Q5 (a)	**Explain any two.** i. Transportation lag ii. Damping coefficient iii. Cascade controllers iv. Transfer Function	 [05] [05] [05] [05]
Q5 (b)	Show that in case of Proportional control of a stirred tank heater for servo problem there is an offset.	[05]